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ANDENDIORITE IN JAPAN.

IN the northern fringe of the Kwanto plain, the environs of Tokyo, there is a series of volcanoes, including Asama, Haruna, Akaki, Niko, and Nasu, some of which are active, while the others are totally extinct. One of the oldest rocks erupted from these volcanoes is exposed at Usui Pass, in the form of propylite. The pass makes several trends along the steep, rocky slope of propylite mountains, and the railway of the Abt system passes through the rock by means of twenty-six tunnels. The propylite directly overlies the Miocene beds.

The propylite seems to have been derived from augite-andesite; the normal variety has a homogeneous aspect, looking like a common andesite. The usual forms are altered. They are white or pale greenish, with scattered granular or sometimes cubical crystals of pyrite. Yellowish epidote grains and calcite crystals are also distinctly observed.

Midway between the telegraphic posts No. 367 and No. 368, on the same pass, I have seen, piercing through the above mentioned propylite, an interesting diorite dike, extending in an east and west direction. The eastern part of the dike is coarse-crystalline, while the other end is fine-granular or somewhat porphyritic.

The diorite, which is manifestly younger than the Miocene beds, is a hypidiomorphic aggregate of plagioclase and hornblende, with quartz, magnetite, iron pyrite, and remains of augite, sometimes mixed with hornblende. Epidote and chlorite, besides secondary pyrite, are also very common as secondary products. The plagioclase is distinguished with the naked eye as milky white grains, while the hornblende is greenish black, with a resinous luster on the newly cleaved surfaces. Iron pyrite and epidote grains are always found on the fresh surface of the rock, with their characteristic colors.

The plagioclase, which is the most important essential

ingredient in the rock, under the microscope is somewhat clear and fresh, exhibiting the extinction angle of labradorite. The albite type is the most common among twins, and the pericline type, also, is frequently found in the same individuals. Zonal structure, with different optical orientation, is often met with. Sometimes the core exhibits an eight-sided section, while the outline of the whole crystal is nearly rectangular. The crystal is often partly idiomorphic and partly allotriomorphic. It usually contains glass enclosures, which are seldom zonally arranged. Sometimes immovable gas bubbles are seen. The presence of liquid enclosures is very uncertain. The feldspar is generally fresh and clear. Decomposition begins at the cracks, where epidote grains are produced. In some cases they entirely replace the feldspar.

Next to the feldspar, the most abundant mineral is hornblende, either fibrous or compact, which fills up the interspaces between feldspar crystals. The characteristic cleavage along (110) is very distinct. The prevailing color is green, with the following pleochroism: **a** = greenish brown, **b** = brownish green, **c** = green. The extinction angle is about 12° , but the decomposing individuals exhibit an undulatory extinction. Many of the hornblende crystals are derived from augite. The sections of the latter are brownish in color, with a greenish tinge, compact in texture, with their characteristic cleavage and an extinction angle of about 38° . Sometimes such a compact augite is converted into one with granular texture, each of the grains retaining the optical property of augite. The granular augite is converted into fibrous hornblende. These fibers are generally united in bundles, parallel to each other. The vertical and ortho-axes of the primary augite and of the secondary hornblende are nearly always in parallel position, sometimes forming a pseudomorph of hornblende after augite, which is distinctly seen in cross section. The green fibrous hornblende is further decomposed into epidote grains or chlorite. Occasionally all these stages of alteration may be seen in one section, surrounding each other in regular order.

Quartz which is surely primary is totally allotriomorphic, and fills up the interspaces between feldspar crystals. It is always fresh, contains glass enclosures, and sometimes well-shaped crystals of pyrite.

Magnetite is very common. An opaque ore, perhaps ilmenite, undergoes decomposition in such a manner as to leave more resisting lamellæ cutting each other at 60°. The pyrite contained in quartz is certainly of primary origin.

Notwithstanding the holocrystalline structure of the rock, there are, occasionally, remnants of groundmass, which consist of microscopical grains of plagioclase, hornblende and iron ores. In a fine granular, porphyritic variety of the diorite, phenocrysts of feldspar are scattered in the aggregate of smaller lath-shaped feldspar individuals, which corresponds to the groundmass of the neovolcanic rocks. The above mentioned facts seem to show that the diorite is not a normal plutonic rock, but most probably a sheet or dike, which has solidified in the region of slight pressure.

Contact metamorphism.—In the neighborhood of the diorite, the propylite is so highly decomposed that traces of the contact metamorphism cannot be recognized. Although the Tertiary beds are never found in contact with the diorite dike, a Tertiary shale found about 330 feet to the north of the diorite is hardened like a hornstone and contains iron pyrite, which is not usual with the unaltered shale of the region. This change of shale seems to be due not to the action of the propylite lying between the diorite dike and the shale but to the diorite itself, which, in fact, has been taken out from a railway tunnel excavated close to the exposure of the shale. It seems probable that similar diorite dikes run through the Tertiary beds everywhere beneath the surface, because we frequently find hardened shale with a contact mineral, whose exact nature has not yet been ascertained.

Stelzner ¹ describes a quartz-bearing mica-diorite of Argentine under the name of "Andendiorit" as a neovolcanic dike

¹ STELZNER, *Geologie u. Paläontologie von Argentina*, p. 213.

rock in the following words : "U. d. M. beobachtete man sehr deutlich Plagioklas, Quarz und braunen Glimmer ; daneben scheinen auch noch kleinen Menze von Orthoklas und Hornblende vorhanden zu sein. Der Plagioklas ist sehr frisch, wasserhell, hier und da etwas rissig ; er hat oft zonalen Bau beherbergt, wieder die oben bereits mehrfach beschriebenen Glasseinschlüsse von der Form negativer Krystälchen mit anhaftenden opaken Körnchen, ferner einzelne Flüssigkeitseinschlüsse, Dampfporon und farblose, sowie blassgrüne Mikrolithen. . . . Die Hornblende tritt uns vereinzelt auf, und ist bereits durchgängig stark zersetzt und zerfasert."

The diorite at Usui Pass is also a Tertiary eruptive, and closely resembles Stelzner's andendiorite in the microscopical properties of the plagioclase, especially in the zonal structure and the glass enclosures with attached opaque granules, which are nearly always absent from the true plutonic diorite.

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